

heard mentally, though not with my ears, as "only 30 seconds more"—the structure of the corona was simply exquisite and strongly developed. I at once exclaimed, "like Orion!" Thousands of interlacing filaments varying in intensity were visible, in fact I saw an extension of the prominence-structure in cooler material. This died out somewhat suddenly some 5' or 6' from the sun, I could not determine the height precisely, and then there was nothing; the rays so definite to the eye had, I supposed, been drawn into nothingness by the power of the telescope; but the great fact was this, that close to the sun, and even for 5' or 6' away from the sun, there was nothing like a ray, or any trace of any radial structure whatever to be seen. While these observations were going on, the eclipse terminated for the others, but not for me. For nearly three minutes did the coronal structure impress itself on my retina, until at last it faded away in the rapidly increasing sunlight. I then returned to the Savart, and saw exactly what I had seen during the eclipse, the vertical lines were still visible!

Captain Maclear has promised to forward to you himself an account of his observations. I need only here therefore refer to their extreme value, adding what I should have stated before, that I saw the bright lines at the cusps, as he was so good as to draw my attention to them. I am however not prepared to say that they were visible through a large arc of retreating cusp.

Dr. Thomson confined his observations to the polariscope, using the Savart. He states that his observations were identical with my own.

Mr. Davis's photographic tent was below the cavalier in which our telescopes had been erected; and immediately after the observations I have recorded were over, I went down to see what success had attended his efforts. I was hailed when half-way there with the cheering intelligence "five fine photographs," and so they are, those taken at the beginning and end of the eclipse being wonderfully similar, with, I fancy, slight changes here and there; but on this point I speak with all reserve until they have been examined more carefully than the time at our disposal has permitted, and until they have been compared with those taken at Ootacamund, Avenashi, and, I hope, at Jaffna and Cape Sidmouth.

This exhausts the principal work done by the Bekul party, with the exception of the sketchers with General Selby at their head, who have recorded most marked changes in the form of the outer corona, and Mr. Webster, who was so good as to photograph the eclipse from a fort some eight miles away, with an ordinary camera, and obtained capital results.

Next a word about the Poodocottah, the other fortunate Indian party. Prof. Respighi has promised to send his results to you with this. About Mr. Holiday's labours I know nothing, except that he has obtained three sketches.

Concerning the Ceylon parties I give you a verbatim extract from the telegrams. From Jaffna: "Exceedingly strong radial polarisation, 35' above the prominences; corona undoubtedly solar to that height, and very probably to height of 50'." From Trincomalee Mr. Moseley informs me that he carefully watched for Young's bright line stratum, and did not see it, and that 1474 was observed higher than the other line.

This is the sum total of the information which has at

present reached me. It is clear there are discordances as well as agreements, the former being undoubtedly as valuable as the latter. It remains now to obtain particulars of all the observations of all the parties, before a final account can be rendered of the eclipsed sun of 1871. This, of course, will be a work of months; but if all goes well, I trust to obtain information shortly of the outlines of the work done by the Indian observers and M. Janssen, as I am now remaining in India for that purpose, and this I will communicate to NATURE by the earliest opportunity. In the meantime I hope the good people at home will think we have done our duty, and that all the members of the Government Eclipse Expedition of 1871 will soon be safely with them to give an account of their work.

J. NORMAN LOCKYER

Ootacamund, Dec. 19, 1871

CAPTAIN MACLEAR'S OBSERVATIONS

LONG before this, no doubt, you have heard of the success of the expedition, but you must be anxious to hear more of the details, and what the observations really were. When I last wrote to you from Point de Galle,* the expedition had arrived there on November 27th in the *Mirzapore*, and was about to proceed to the different stations selected. The Ceylon sections left on the 28th in the Colonial steamer *Serendib*, placed at our disposal by the Government. She was to leave Messrs. Moseley and Ferguson at Trincomalee, and then proceed to Jaffna, with Captain Fyers, R.E., Captain Tupman, R.M.A. and Mr. Moseley. We have since heard of the safe arrival of these gentlemen at their stations, and, by telegraph, of their successful observations on December 12th.

The Indian parties left Galle on the 28th in H.M.S. *Glasgow*, flag-ship of Admiral Cockburn, who kindly gave us his cabin accommodation. With a fair wind we made sail, and arrived at Bepore on the night of the 1st December. The next morning we landed Signor Respighi and Mr. Holiday to go by train to Poodocottah, and then we left for Cannanore where Messrs. Abbay and Friswell were disembarked to make their way across country to their station at Manantoddy. They had a troublesome and fatiguing journey to perform, with heavy instruments, which however they safely accomplished in three days, and we can only heartily regret that their labours were not recompensed by fine weather on the morning of the eclipse. At Cannanore we were fortunate enough to enlist the services of General Selby, commanding the troops; he came across to Bekul, and rendered good aid in making some valuable sketches of the corona during the eclipse.

We left Cannanore on the 3rd, and with the strong tide that sometimes runs up that coast, were only six hours in reaching Bekul. We found that Mr. McIvor, assistant collector, and Mr. Pringle, engineer, had arrived that morning from Mangalore, on the part of the Indian Government, had prepared the travellers' bungalow for our reception, and had cleared the keep of an old fort erected by Tippoo which would make a capital observatory. The bay is open and shelving, but there

* See NATURE, vol. v. p. 163.

was little surf, and on the morning of the 4th, instruments and all were safely landed and carried up to the fort.

Our voyage in the *Glasgow* had been uneventful; but I cannot take leave of her without speaking of the kindness and assistance we received from Captain Jones and all on board, and we were truly sorry that the duties of the station did not allow them to remain and give us that aid, which, with the interest that all took in the work, would have been so invaluable.

Bekul is an out-of-the-way place, twenty-five miles from Mangalore, from which place all our supplies had to be carried on the backs of coolies; this did not, however, prevent several gentlemen, interested in our proceedings, coming out to join us.

Our party consisted of four who came out from England, viz., Mr. Lockyer, Dr. Thomson, Mr. Davis, and Commander Maclear, besides Messrs. McIvor and Pringle, to whose foresight and care we are very much indebted for our success. It was further strengthened by Mr. Webster, collector at Mangalore, who took some valuable photographs during the eclipse, by General Selby from Cannanore, and several others, making our numbers up altogether to eighteen. Our bungalow was about a mile from the fort, of which the highest bastion in the inner rampart had been selected to mount the equatorials; it was in a most commanding position about eighty feet above the sea, and overlooking a vast extent of country. Just below us, in a well-sheltered spot, Mr. Davis fixed his camera and dark chamber.

The day of our landing the heat of the sun was terrible, and we had to wait till the cool of the afternoon before we could proceed to work. That night, however, a great advance was made, the bases of the equatorials were up, and all ready for the tubes, and a "chuppa," or awning of palm leaves erected to protect them from the night dews and midday sun. The next seven days were employed in getting our instruments perfectly adjusted and in practising with them. The weather left nothing to be desired, except that the sun would take his revenge out beforehand and strike down with such force as to render it impossible to work in the middle of the day. Only one morning was cloudy, and then not to an extent that would have interfered with observations. At night the stars shone with great brilliancy, and we had great delight in observing the clusters and nebulae, pity we could not have remained longer to make spectroscopic observations of the latter in such a clear atmosphere.

The morning of the 12th dawned bright and clear, only a few small clouds to be seen near the western horizon, a light breeze from the N.E. All were early at their stations watching anxiously the appearance of the sun, which rose over the distant hills about half-an-hour before the commencement of the eclipse. But now I shall speak only of my own observations; Mr. Lockyer has already given the account of those made by himself.

The instrument I used was a double equatorial of two 6-inch refractors mounted on the same base, one at either end of the declination axis. To one was attached a 6-prism spectroscope from Kew, lent by Mr. Spottiswoode, of great dispersive power. To the other was fixed a spindle bar, carrying an erecting eye-piece, and a 7-prism direct vision spectroscope, either of

which could be swung at pleasure into the focus of the object glass; the two tubes had been carefully made parallel, so that the same object was viewed in both telescopes. The 6-prism was worked nearly the whole of the time by myself, and the direct vision by Mr. Pringle, who had practised with it constantly during the last few days. I add the observations made by him. At the commencement of the eclipse the slit of the 6-prism was placed tangential to the point of contact, that of the direct vision radial, width such that the absorption lines were very distinct, but not too fine. No change was observed from the ordinary solar spectrum. Keeping the slit for the next quarter of an hour tangential to the northern cusp, C was very bright the whole length; F bright, but thin. The slit was then placed radial to the cusp, and four bright lines near C (besides C itself) became visible, one on the direct side within 10 units Kirchhoff, and three on the red side within 20 units, the length of all five varying, but not together the average being about $\frac{1}{8}$ the height the visible spectrum.

At 6h. 51m. M.T., twenty-five minutes after contact, on a large prominence, C lengthened to half height of spectrum; nine minutes afterwards cusp was at another prominence, the positions of these must have been about N. 13° , and nearly north.

At 7h. 8m. M.T. I watched with the direct vision radial and, besides the Hyd. and "near D" lines, observed another bright line a little more refrangible than the air band between δ and F. At 1830 Kirchhoff it was very faint, and soon disappeared; soon after this I saw F line double about the same height as usual, $\frac{1}{8}$ spectrum.

At 7h. 23m. M.T., having returned to the 6-prism radial to the cusp, I observed the Hyd. D, E and δ very plain; several lines then began to come into view, as near as I could judge all the iron lines from halfway between D and E to beyond δ . These kept on brightening and more lines coming in. I called Mr. Lockyer to look at the phenomenon, and we watched it together for two or three minutes until it became time to take position to observe totality. During these two or three minutes the cusp must have passed from about N. 38° E. to N. 70° E. or further, and the lines were not lost sight of till I moved the telescope and placed the slit tangential to the point where the light would disappear, keeping it there with R.A. movement. On looking through the spectroscope the field was full of bright lines, the light just enough to let me distinguish the positions from the well-known solar lines.

As totality came on the light decreased, and the lines increased exceedingly, rapidly in number and brightness, until it seemed as if every line in the solar spectrum was reversed; then they vanished, not instantly, but so quickly that I could not make out the order of their going, except that the Hyd. D, δ , and some others between D and δ , remained last. Then they vanished, and all was darkness. I then unclamped, and swept out right and left, but saw nothing; then went to the direct vision, but saw nothing; placed the telescope on the moon's limb by the eye-piece, then put in the spectroscope, but the light was not sufficient to show any spectrum; pointed the telescope carefully, first on the dark moon, and then on a bright part of the corona, but no spectrum. I then looked at the corona with the naked eye, saw a bright glory around the moon, stellar form, six-pointed, something like the nimbus

painted round a saint's head, extending to a diameter and a half. Looked through the finder, and saw the same form, but very much reduced in size and brilliancy; then examined with the 6in. and eye-piece, and saw nothing but a bright glow round the moon, not much more than the height of the big prominence plainly visible in the S.E. quarter. The last thirty seconds had now arrived, and, as previously arranged, Mr. Lockyer took my place at the 6in., while I again looked through the 6-prism spectroscopic to record anything that might be visible, but I saw nothing. As the spectroscopic was not on the sun's limb at the re-appearance of the light, I cannot state what took place.

During the remainder of the partial eclipse I watched the northern cusp as the moon uncovered the sun, and several times I saw distinctly the four bright lines near C; but saw nothing else worth recording.

The colour of the corona appeared to me a light pinkish white, very brilliant. I saw no streamers. The rest of the sky and everything around had a bluish tinge.

I will now give an extract from Mr. Pringle's report. He was observing with the direct-vision spectroscopic attached to the other 6-inch telescope, and with myself watching the northern cusp, slit radial:

"Until 6h. 47m. (mean time) bright lines C, near D, and F, of uniform brightness, and varying but slightly from normal height. At that time F brightened, C remained bright, line near D very faint. At 6h. 54m. all the lines lengthened to some four or five times their normal height, showing a prominence at the cusp. For the next ten minutes lines varying but little. At 7h. 4m. a large prominence at cusp; bright lines lengthening some eight or nine times their normal height. At 7h. 4m. 30s. a bright line appeared on the more refrangible side of F, and close to it, F lengthening considerably, and bending towards the red. All the before-mentioned lines were now bright, F longer than the rest, and remaining bent, the line near it being one-third its length. At 7h. 13m. observed three bright lines at δ , visible only at the extreme point of the cusp. Half a minute before totality, turned the slit tangential; but the slit not being exactly at the same place as that of Commander Maclear's, both refractors working by the same slow-motion screw [this was owing to the sway of the bars carrying the spectroscopic when it was being turned.—J. P. M.] I failed to obtain any results at the moment of totality. I then observed at the 6-prism just quitted by Commander Maclear, whilst that gentleman, observing at the direct-vision spectroscopic, swept out from the sun on one side, then brought the finder on the dark moon, and thence swept out from the sun on the opposite side. During this time nothing whatever was visible in the spectroscopic. I next observed with the naked eye: corona appeared radial, of a purplish white colour, brightest near the body of the moon; no very long rays perceptible. On holding the head sideways, rays of corona remained permanent, showing none to be due to defect of vision. Next observed corona through $2\frac{1}{2}$ " finder of refractor. Structure well-defined, wavy, nebulous, permanent. Remarkable a curiously-curved portion of corona, divided by a partial rift from an oblique ray. I should imagine the corona to extend about $7'$ beyond the sun, but did not accurately estimate the distance

whilst observing. When thirty seconds of totality remained, I went to finder of equatorial reflector; structure of corona not so apparent with higher power. Several prominences visible; one of large size, structure similar to that of corona. At about twelve seconds before end of totality, a perceptible brightening along the edge of the moon on the side of appearance; a few seconds before end of totality, I went to one prism corona spectroscopic attached to $7\frac{1}{4}$ " reflector. At the end of totality a considerable number of bright lines flashed in (what proportion of the whole I cannot say, perhaps a third). The line near D noticeably bright; continuous spectrum faintly visible a moment before the sun's limb showed. After totality observed at finder, the summit of a large prominence opposite the point of sun's re-appearance visible for several seconds after totality."

During the afternoon I tried to make an accurate sketch of the prominences on the sun's disc, but clouds came on, and I was prevented. It was not worth while keeping the instruments up another day for the purpose, so we commenced, and in two days they were safely packed for Bombay.

The rumours that our presence gave rise to among the natives were very amusing. First we heard that part of the sun was about to fall, and the wise men had come to the East to prevent it. Then when the formidable-looking instruments were seen mounted on the fort, they thought there was a war, and we were engineers going to put the fort in order to prevent a landing. This was strengthened by the fact that the *Glasgow* practised at a target before returning to Ceylon. This gave place to a flood about to descend, and all the Europeans were coming to the high ground to escape it.

When the eclipse commenced the usual shouting and beating of tom-toms went on, but a cordon of police prevented an invasion of the Observatory, and only a confused noise from below reached us.

J. P. MACLEAR

S.S. *Indus*, January 6, 1872

MORSE ON TEREBRATULINA

The Early Stages of Terebratulina septentrionalis. By Edward S. Morse, Ph. D. (Boston Society of Natural History, vol. ii.)

MR. MORSE is one of the band of New England naturalists who have lately been making themselves known to us through that excellent periodical the *American Naturalist*, and who have shown themselves determined to take advantage of the opportunities offered to them by the presence on their sea-board of such zoological treasures as *Limulus* and *Lingula*. Mr. Morse obtained *Terebratulina* in abundance in the harbour of Eastport, Maine, and gives in this paper an account of the change in the form of the shell and the "arms" during development of this Brachiopod from a scarcely visible speck onwards. The changes are illustrated in two plates containing outline figures, and as far as Mr. Morse has observed consist firstly in the passage of the shell from a flat and shorter form to the elongated and convex shape with which we are familiar. Further, the